**WHAT WE CLAIM IS:**

1. An apparatus for electrical detection of molecular interactions between an immobilized probe and a target molecule, comprising:

(a) a supporting substrate,

(b) a plurality of microelectrodes in contact with the supporting substrate to which probes are immobilized,

(c) at least one counter-electrode in contact with the supporting substrate,

(d) a means for producing electrical impedance at each microelectrode,

(e) a means for detecting changes in impedance at each microelectrode in the presence or absence of a target molecule, and

(f) an electrolyte solution in contact with the plurality of microelectrodes and the counter-electrode, wherein molecular interactions between the immobilized probe and the target molecule are detected by detecting changes in the electrical impedance in the presence and absence of the target molecule.

2. An apparatus for electrical detection of molecular interactions between an immobilized probe and a target molecule, comprising:

(a) a supporting substrate,

(b) a plurality of microelectrodes in contact with the supporting substrate,

(c) a plurality of conjugated polymer or copolymer films in contact with the microelectrodes and to which probes are immobilized,

(d) at least one counter-electrode in contact with the supporting substrate,

(e) a means for producing electrical impedance at each microelectrode,

(f) a means for detecting changes in impedance at each microelectrode in the presence or absence of a target molecule, and

(g) an electrolyte solution in contact with the plurality of microelectrodes, plurality of conjugated polymer or copolymer films, and the counter-electrode, wherein molecular interactions between the immobilized probe and the target molecule are detected by detecting changes in the electrical impedance in the presence and absence of the target molecule.

3. An apparatus for electrical detection of molecular interactions between an immobilized probe and a target molecule, comprising:

(a) a supporting substrate,

(b) a plurality of microelectrodes in contact with the supporting substrate,

(c) a plurality of polymer gel pads in contact with the microelectrodes and to which probes are immobilized,

(d) at least one counter-electrode in contact with the supporting substrate,

(e) a means for producing electrical impedance at each microelectrode,

(f) a means for detecting changes in impedance at each microelectrode in the presence or absence of a target molecule, and

(g) an electrolyte solution in contact with the plurality of microelectrodes, plurality of polyacrylamide gel pads, and the counter-electrode, wherein molecular interactions between the immobilized probe and the target molecule are detected by detecting changes in the electrical impedance in the presence and absence of the target molecule.

4. The apparatus of Claims 1, 2, or 3, wherein the substrate comprises ceramic, glass, silicon, fabric, or plastic.

5. The apparatus of Claims 1, 2, or 3, wherein the microelectrodes comprise a conductive material and an insulating material.

6. The apparatus of Claim 5, wherein the conductive material is solid or porous gold, silver, platinum, titanium, copper, metal oxide, metal nitride, metal carbide, or graphite carbon.

7. The apparatus of Claim 6, wherein the conductive material is platinum.

8. The apparatus of Claim 6, wherein the conductive material is gold.

9. The apparatus of Claim 5, wherein the insulating material is glass, silicon, plastic, rubber, fabric, ceramic, or combination of such materials.

10. The apparatus of Claim 9, wherein the insulating material is silicon.

11. The apparatus of Claim 9, wherein the insulating material is glass.

12. The apparatus of Claim 5, wherein the conductive material is embedded in the substrate and the substrate comprises the insulating material.

13. The apparatus of Claims 1, 2, or 3, comprising at least one reference electrode is optional.

14. The apparatus of Claim 13, wherein the reference electrode comprises a conductive material and an insulating material.

15. The apparatus of Claim 14, wherein the conductive material is solid or porous gold, silver, platinum, titanium, copper, metal oxide, metal nitride, metal carbide, or graphite carbon.

16. The apparatus of Claim 14, wherein the conductive material is silver/silver chloride.

17. The apparatus of Claim 14, wherein the insulating material is glass, silicon, plastic, rubber, fabric, ceramic, or combination of such materials.

18. The apparatus of Claims 1, 2, or 3, wherein the supporting substrate further comprises a plurality of wells, each of which encompasses at least one microelectrode and at least one counter-electrode.

19. The apparatus of Claim 2, wherein the conjugated polymer or copolymer film used for probe attachment includes, but is not limited to, polypyrrole, polythiphene, polyaniline, polyfuran, polypyridine, polycarbazole, polyphenylene, poly(phenylenvinylene), polyfluorene, polyindole, their derivatives, their copolymers, and combinations thereof.

20. The apparatus of Claims 19, wherein probes are attached to microelectrodes using a neutral pyrrole matrix.

21. The apparatus of Claims 3, wherein the gel polymer pads are polyacrylamide.

22. The apparatus of Claims 1, 2, or 3, wherein the probes are oligonucleotides.

23. The apparatus of Claims 1, 2, or 3, wherein the probes are nucleic acids.

24. The apparatus of Claims 1, 2, or 3, wherein the probes are peptides.

25. The apparatus of Claims 1, 2, or 3, wherein the electrolyte solution comprises at least one salt containing metal or polymerized cations that are ion-conductive, capable of reacting with probes or probe-target complexes.

26. The apparatus of Claim 25, wherein the salt contains anions having a reduced specific adsorption for the surface of the microelectrode.

27. The apparatus of Claim 25, wherein the electrolyte solution comprises 0.1M $LiClO_4$.

28. A method for the electrical detection of molecular interactions between an immobilized probe and a target molecule, comprising:

(a) contacting a plurality of microelectrodes to which probes have been attached with an electrolyte solution,

(b) measuring the impedance at the microelectrodes,

(c) exposing the microelectrodes to a reaction mixture containing a target molecule in order to generate probe-target complexes, and

(d) measuring the impedance at the microelectrodes.

29. The method of Claim 28, wherein the electrolyte solution comprises metal, non-metal or polymerized cations that are ion-conductive and capable of reacting with probes or probe-target complexes.

30. The method of Claim 28, wherein the electrolyte solution comprises 0.1 M $LiClO_4$ and the lithium cation is capable of reacting with probes or probe-target complexes.

31. The method of Claim 28, wherein impedance is measured over a range of frequencies prior to and after exposing the microelectrodes to a reaction mixture containing the target molecule.

32. The method of Claim 28, wherein impedance is measured by transient methods with AC signal perturbation superimposed upon a DC potential applied to an electrochemical cell.

33. The method of Claim 28, wherein impedance is measured by impedance analyzer, lock-in amplifier, AC bridge, AC voltammetry, or combinations thereof.

34. The method of Claim 28, wherein the molecular interactions detected thereby are single base mismatches within nucleic acid probe-target complexes.

35. The method of Claim 28, wherein the molecular interaction detected is quantification of target molecules in a reaction mixture for gene expression analyses.